Near Real Time Applications for Maritime Situational Awareness

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Maritime Security Lab Neustrelitz

German Remote Sensing Data Center (DFD)

ATLAS MEETS SCIENCE
Bremen, 12.-13. October 2016

DLR

Presentation Outline

Background

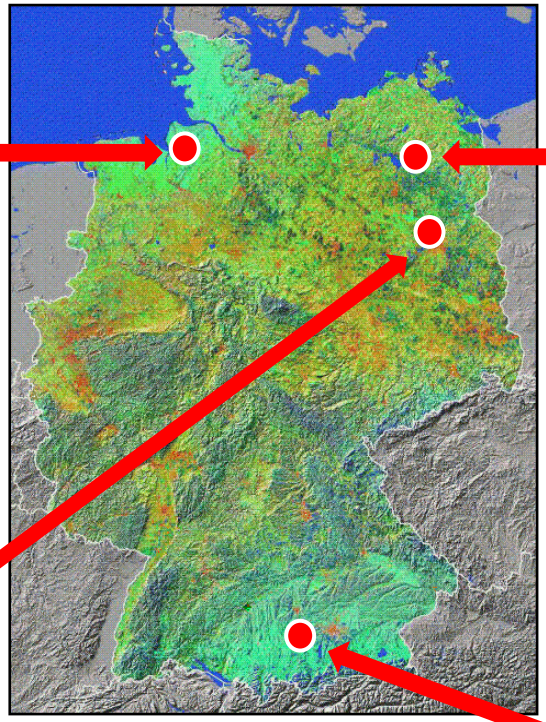
- Earth Observation Center
  - Maritime Security Lab
  - Component of Service Chain

Application Status and Future Development

- Ship Detection
- Oil Detection
- Wind and Wave
- Icebergs, Ice Classification and Ice Drift

Earth Observation Center – EOC

Bremen
Maritime Security Lab



Neustrelitz
National Ground Segment
Maritime Security Lab

Berlin

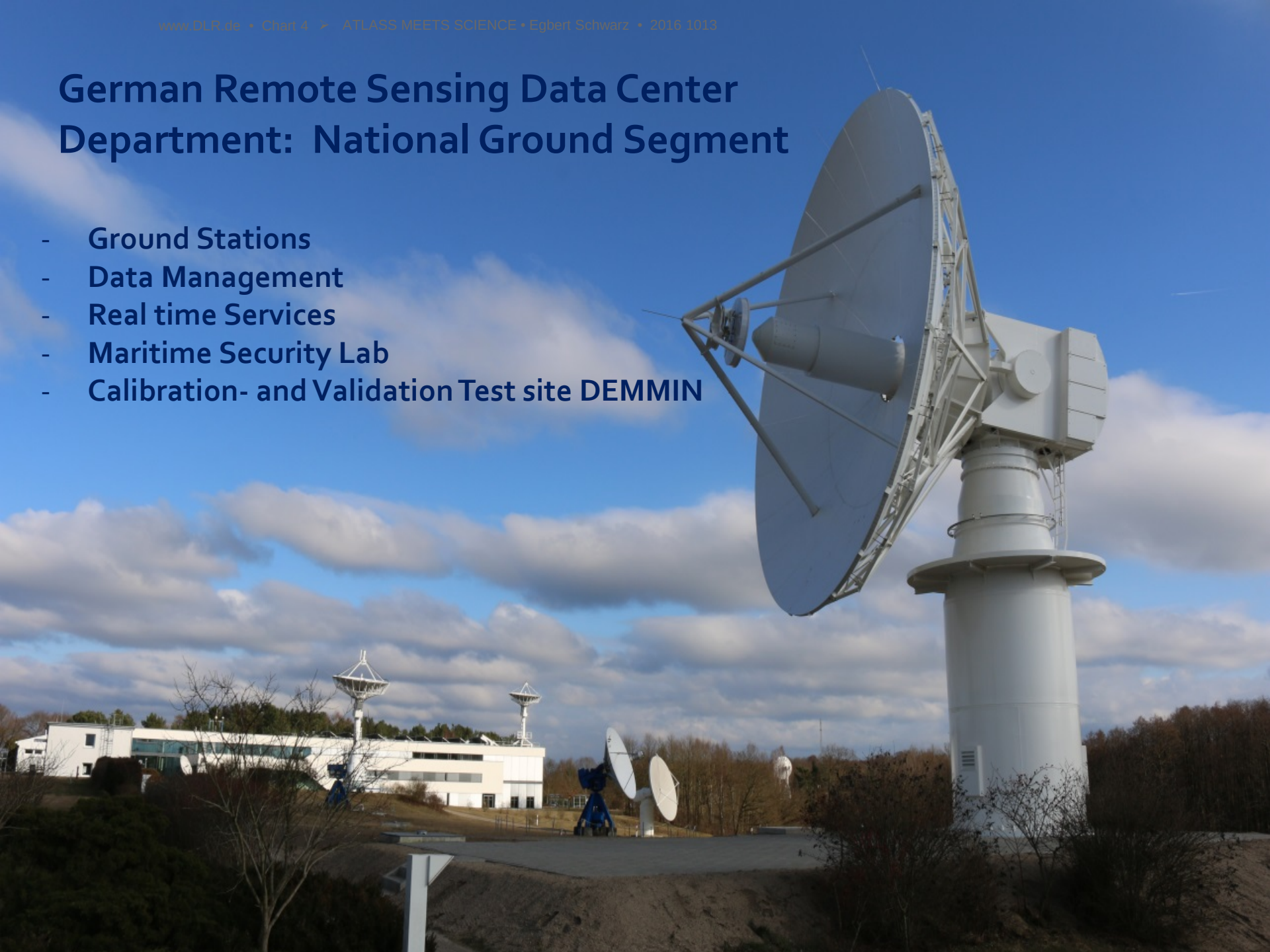
- Consists of the Remote Sensing Technology and the German Remote Sensing Data Center
- Appr. 350 employees at 4 sites
- Chairs at 2 university

Oberpfaffenhofen

DLR

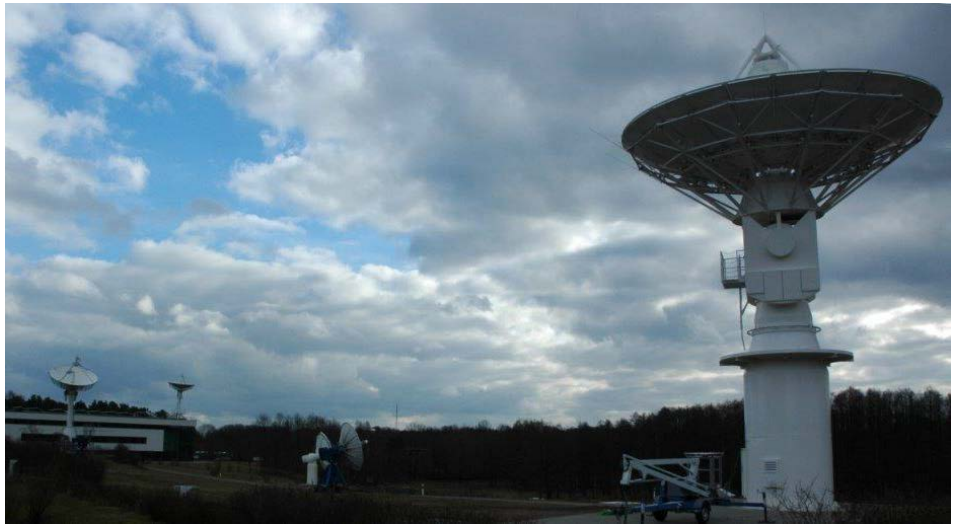
German Remote Sensing Data Center
Department: National Ground Segment

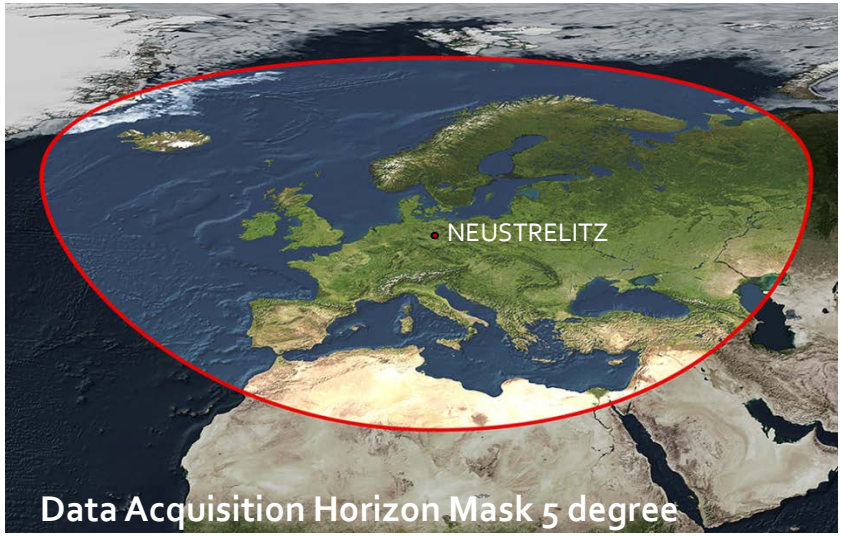
- Ground Stations
- Data Management
- Real time Services
- Maritime Security Lab
- Calibration- and Validation Test site DEMMIN



Ground Station and Processing Facility Neustrelitz

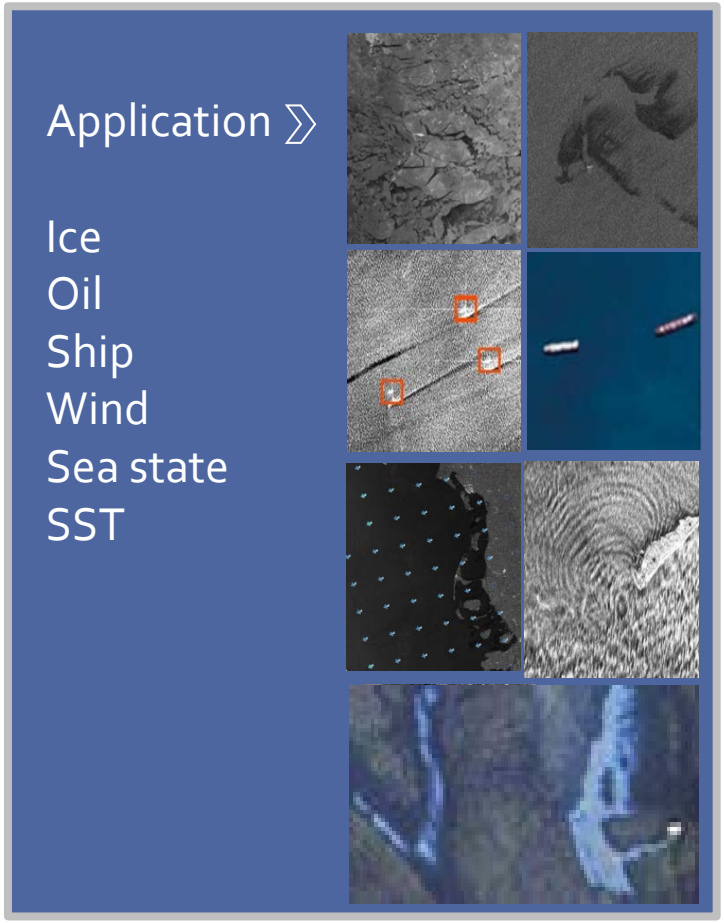
- Support of currently 12 different Satellite missions
- Main reception and processing facility for SAR Mission TerraSAR-X
- Collaborative Station for European Sentinel-1 mission
- Radarsat-2 Regional Ground System for science purpose since Summer 2015
- Landsat-8 Global Network Station

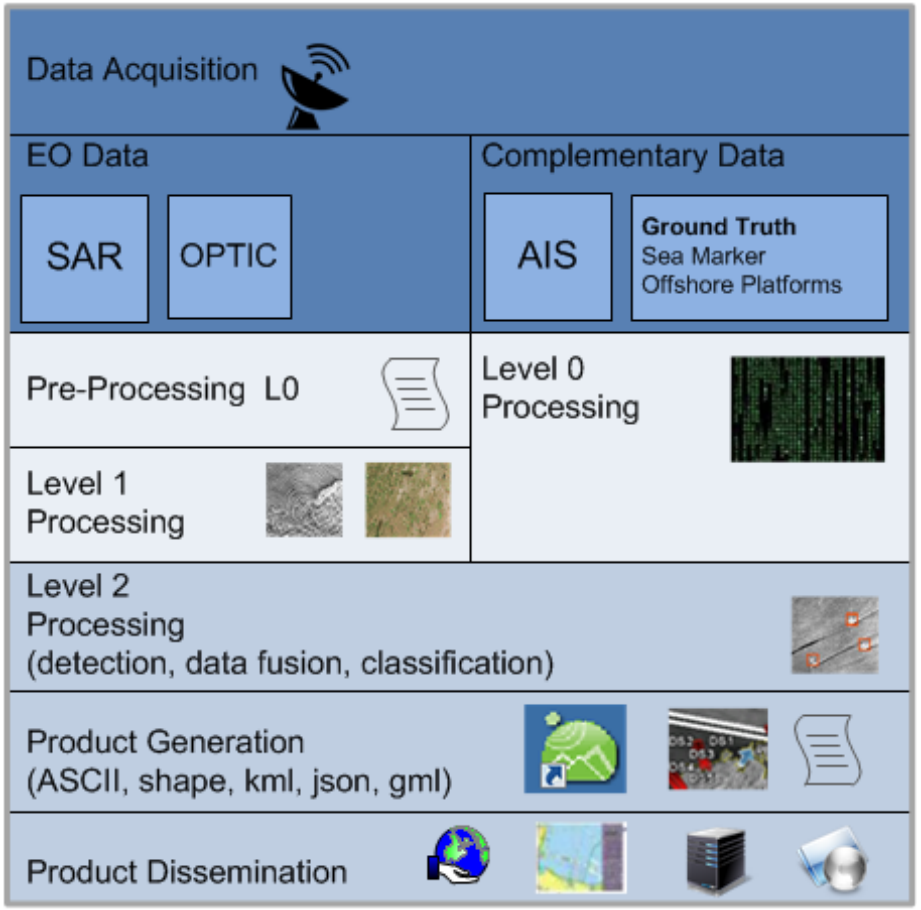




Objective

Research and development of integrated applications enabling specific value added
Maritime Information Products for the Maritime Situational Awareness in Near Real Time

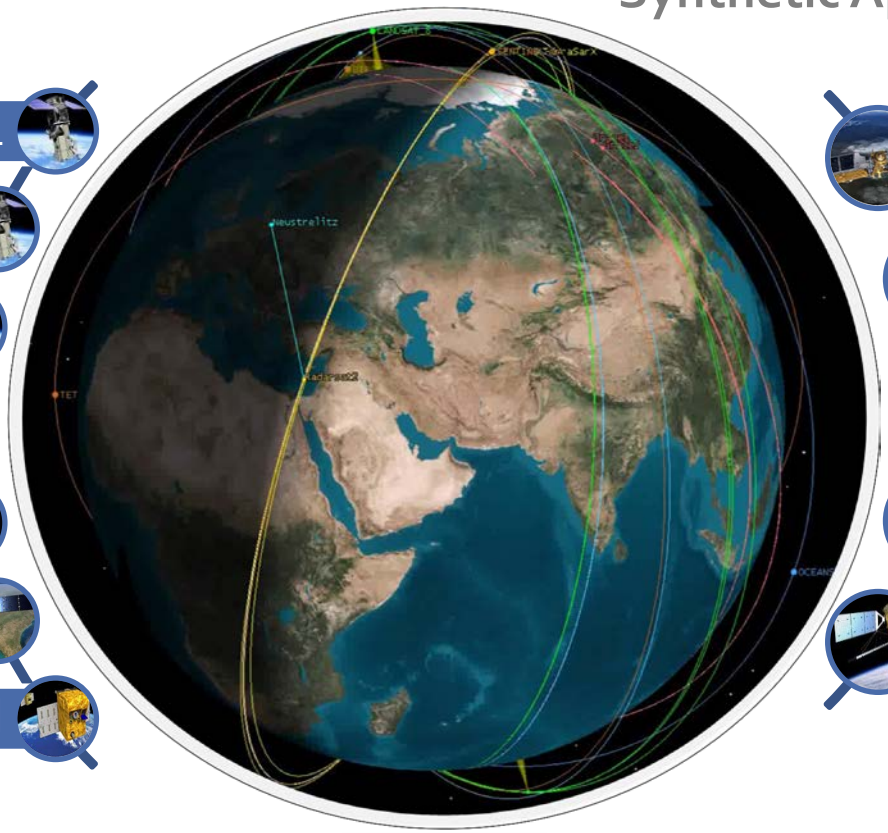




Sensors and Modes

Optical

- Worldview-1
- Worldview-2
- Worldview-3
- GeoEye-1
- Deimos
- Landsat-8
- Firebird



Synthetic Aperture Radar (SAR)

- Sentinel-1A
- Sentinel-1B
- TerraSAR-X
- TanDEM-X
- Radarsat-2

AIS - Satellites

Synthetic Aperture Radar SAR

SAR satellite data enable day/night monitoring and mainly independent from weather conditions (clouds)

Highly automated feature extraction enable fast processing of large volumes of data and information delivery within ~30 minutes of image acquisition

Increasing number of satellite resources

The European Earth Observation Programme COPERNICUS enable free and open data access (Sentinel-1, EU-member)

reduced repeat cycle due to availability of 2 satellites

Large Coverage and very high resolution e.g.

Sentinel-1

- Extra-Wide-Swath Mode (400 km), 20x40 m,
- Interferometric Wide Swath Mode (250 km) , 5x20 m
- Strip Map Mode 80 km swath, 5x5 m

TerraSAR-X

- Strip Map Mode, 50 km swath, 3 m
- High Resolution Spotligth, 5x15-10 km , 1..1 m
- Staring Spotlight (ST) , (2.5 – 2.8)x 6 km, 0,24 m az, 1.0 m rg

High Resolution Optical Sensors

Multi-payload (e.g.WorldView-3)

Very High resolution up to 31 cm panchromatic

up to 1.24 m multispectral resolution , 3,7 m short-wave infrared resolution

High flexibility (acquisition of coastlines)

Increasing number of satellite resources and satellite constellations (Digital Globe, AIRBUS)

European Earth Observation Programme COPERNICUS enable free and open data access (Sentinel-2, Sentinel-3,)

reduced repeat cycle due to availability of 2 satellites

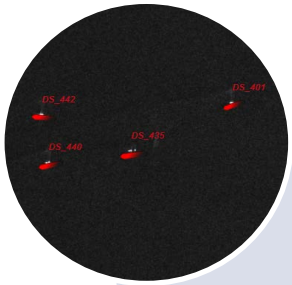
Multi-payload

Sentinel-3

- Ocean and Land Colour Instrument OLCI,
- Sea and Land Surface Temperature Radiometer SLSTR,
- Synthetic Aperture Radar Altimeter SRAL

https://sentinel.esa.int/web/sentinel/thematic-areas/marine-monitoring/marine-safety

Ship- Detection Application (SAR)



Near real time ship detection application based on SAR images

currently developed for:

TerraSAR-X, TanDEM-X

Radarsat-2, Sentinel-1A,

Sentinel-1B

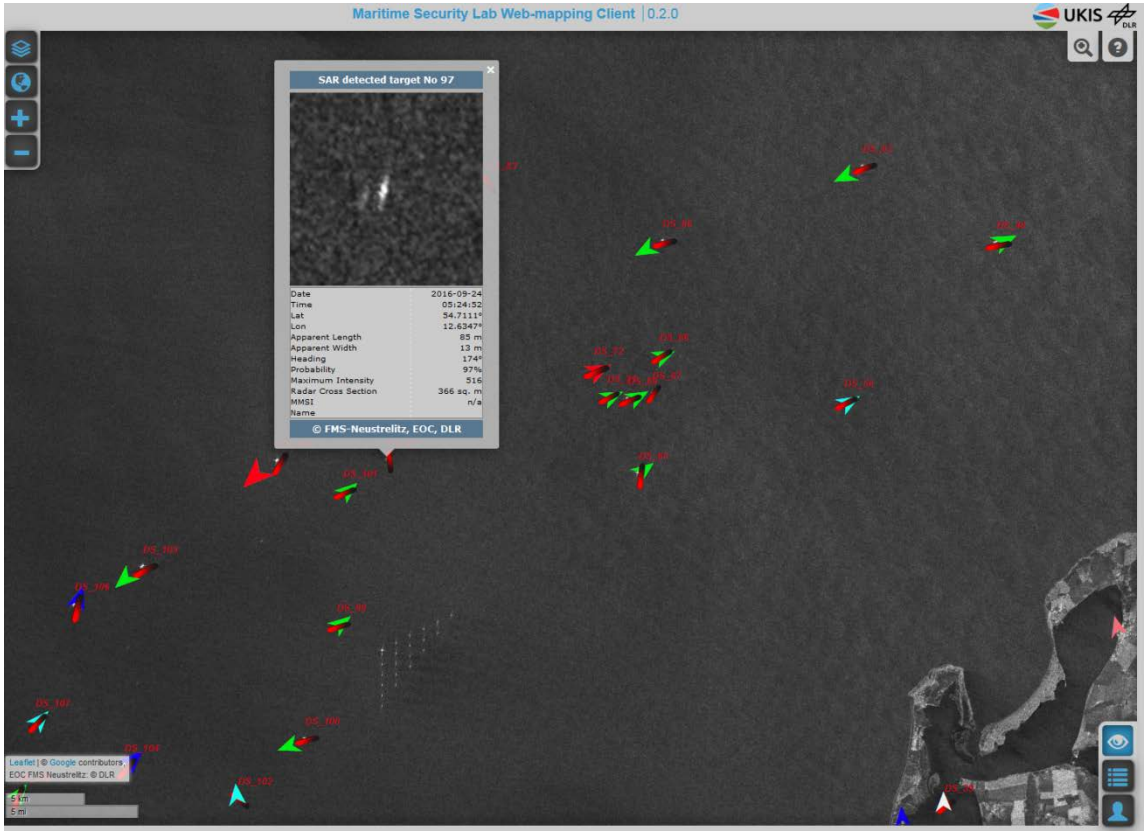
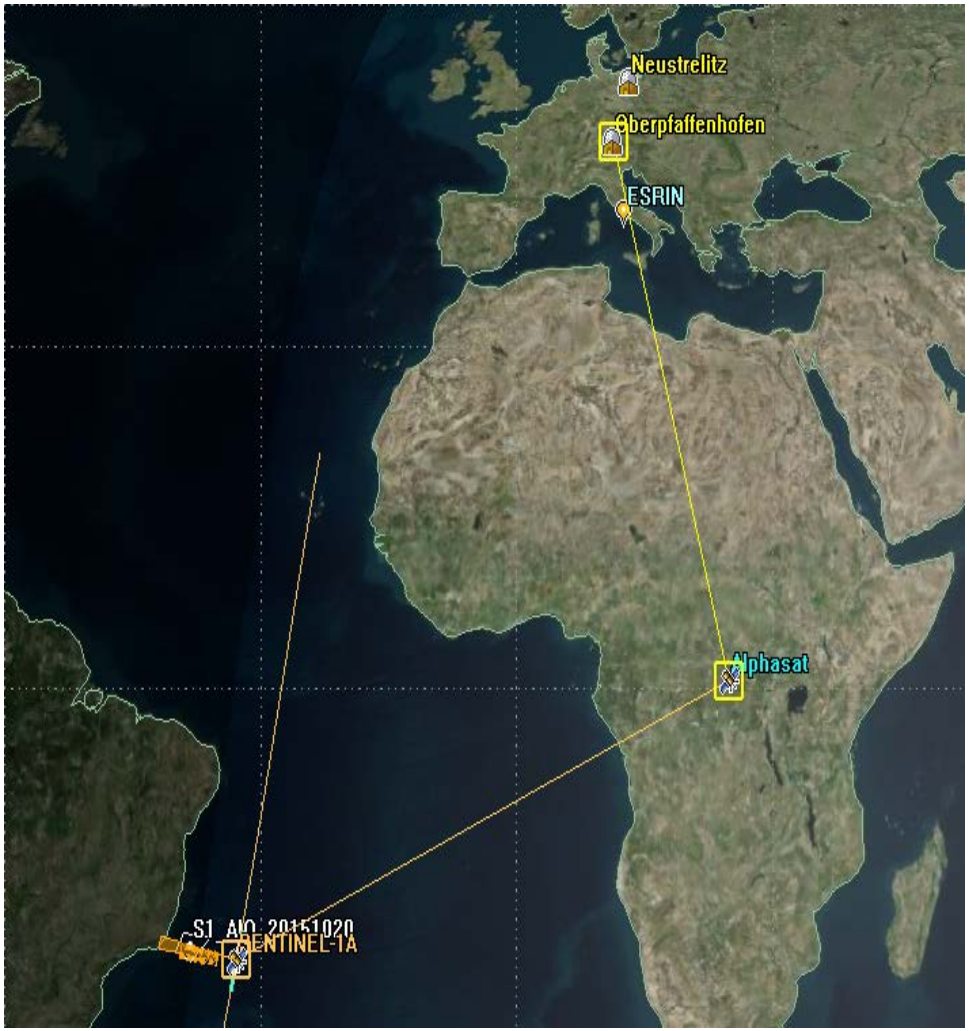


Image: S1A_IW_GRDH_1SDV_20160924T0524

Value added products

- **SAR/ AIS merged products** (in case of available AIS Data)
- ASCII ; KMZ, GML; DER (EMSA); ESRI shape; json;
- GeoTIFF (MRES_L1b; HRES_L1B)

Application Example

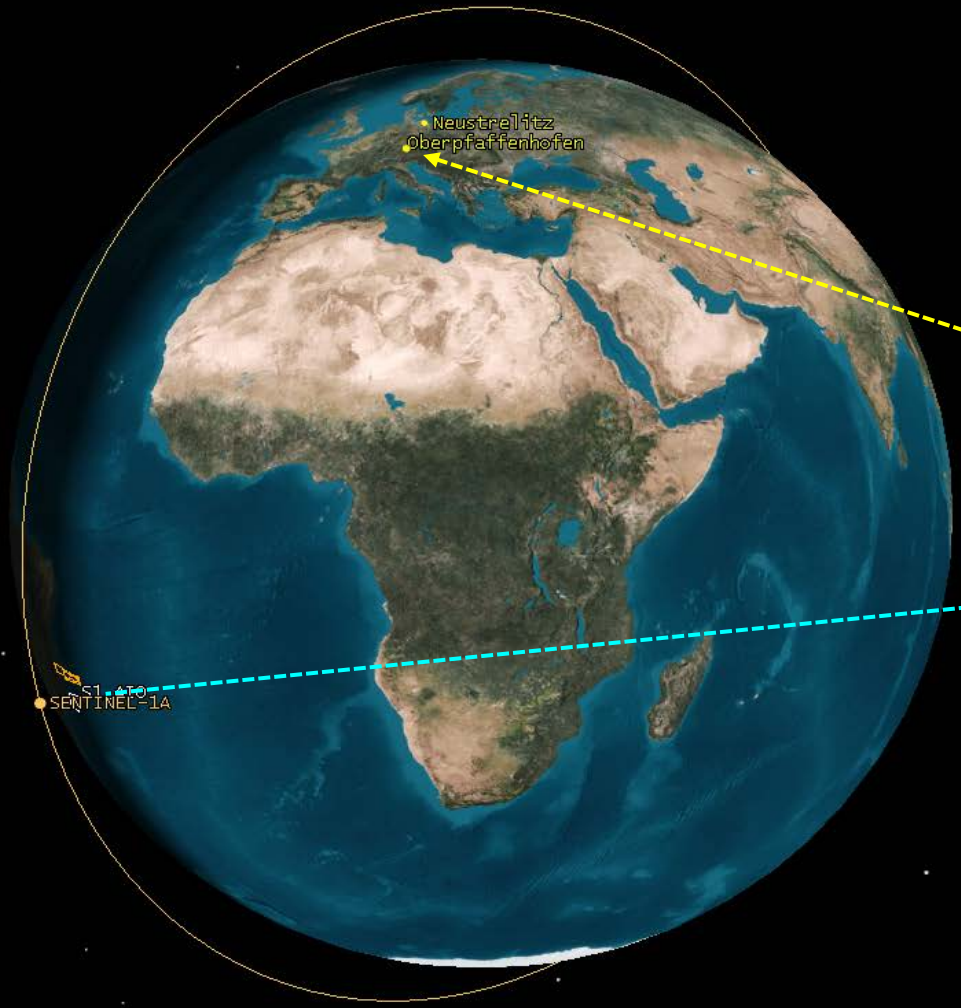


Sentinel-1 Acquisition and Downlink – Alphasat TDP-1 Test

Partners involved:

- ESA ESRIN
- ESA ESTEC
- ESA ESOC
- TESAT
- Eutelsat
- Airbus
- DLR Space Management
- DLR Earth Observation Center
  - Oberpfaffenhofen
  - Neustrelitz

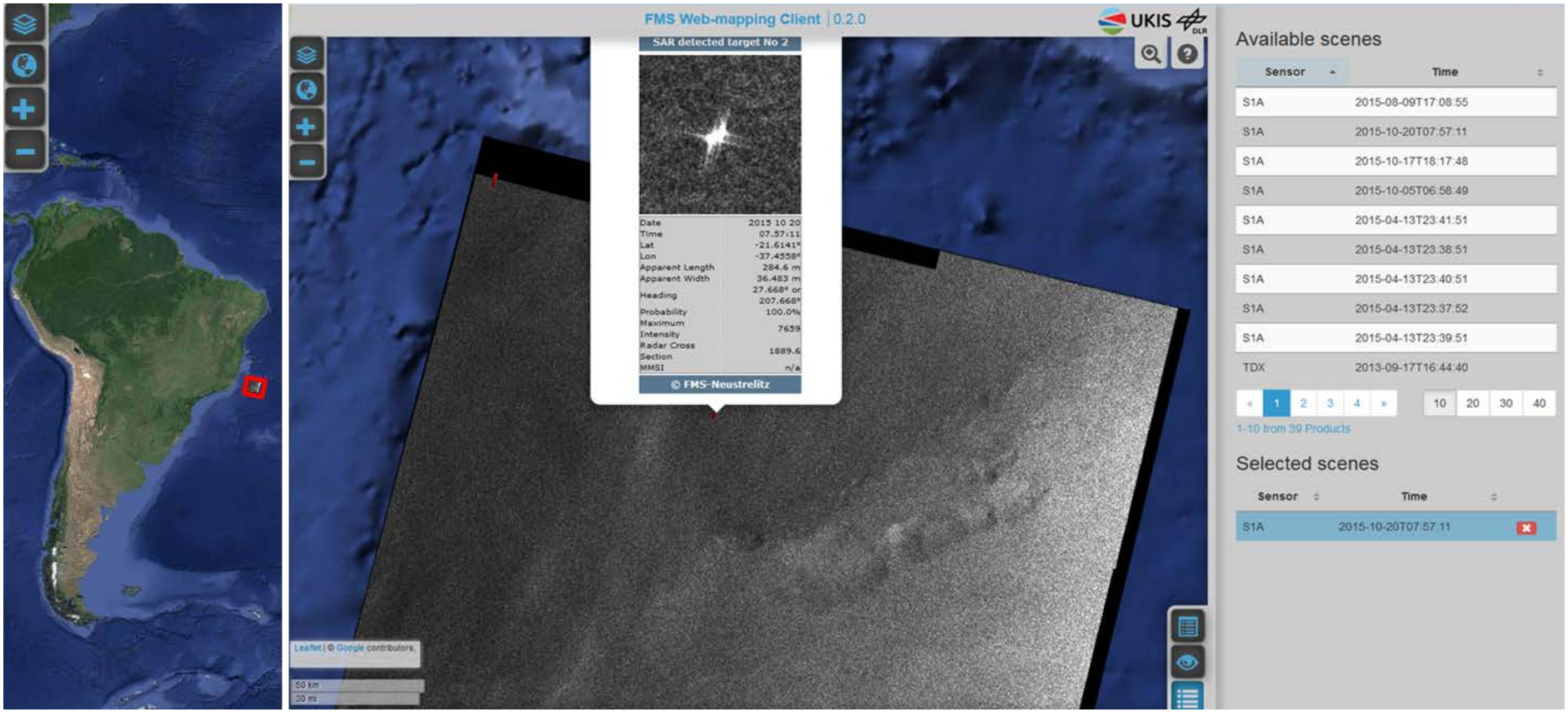
LCT-Link and data reception



Alphasat

- Reception in Oberpfaffenhofen via Alphasat Ka- Band Antenna
- L0 Processing in Oberpfaffenhofen
- Transfer to Neustrelitz and QRT processing and automated ship detection
- End-to-End time: 18 min (further optimization possible)

Alphasat NRT Demo:
L2 ship detection product at DLR Web-mapping Client

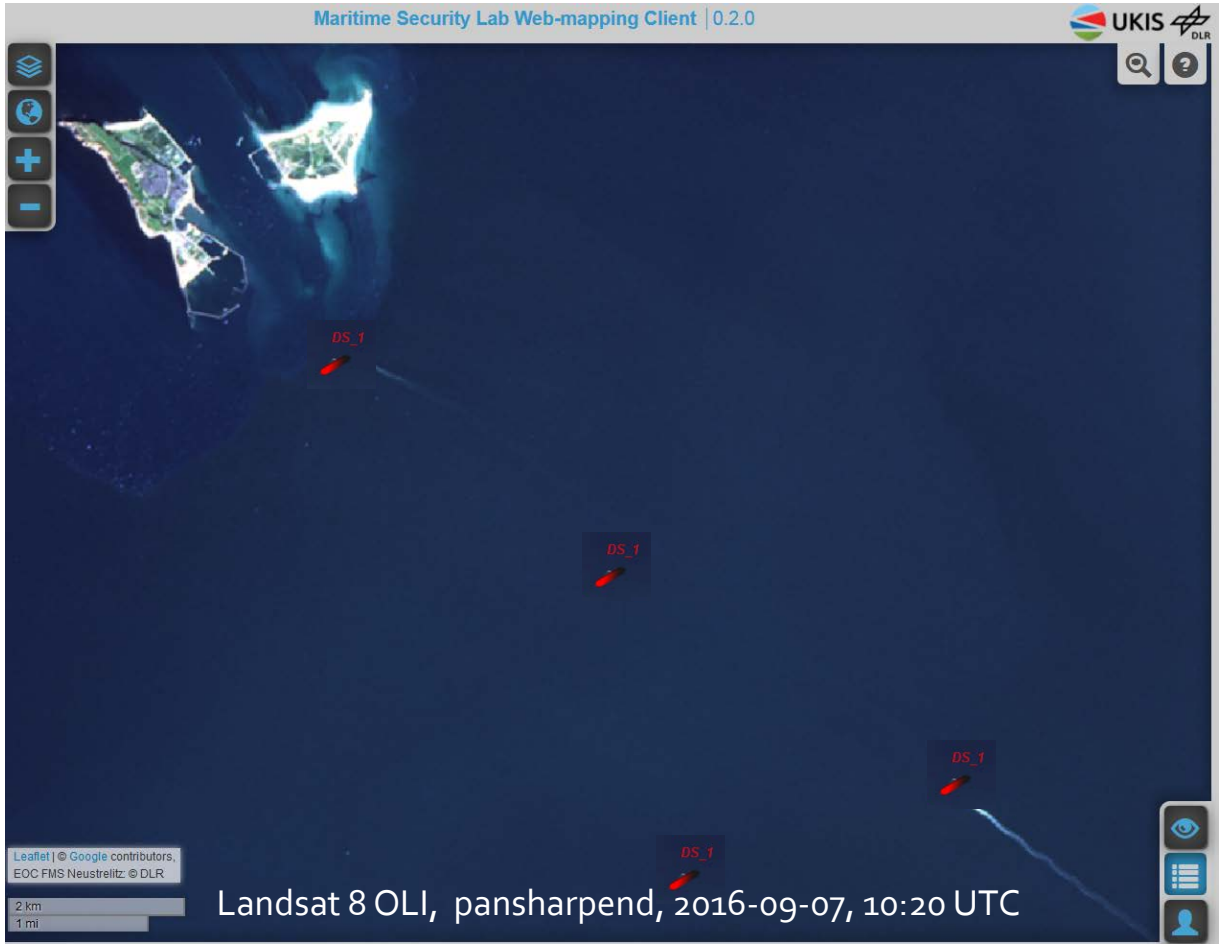


Ship- Detection Application (Optic)

Near real time ship detection application based on optical data

Core processor currently being developed by the Maritime Security_Lab Neustrelitz

planned value added products in near real time based on very high resolution images (Worldview 1-3, GeoEye,)



- Value added products
  - **OPT/ AIS merged products** (in case of available AIS Data)
  - ASCII ; KMZ, GML; VDS (EMSA); ESRI shape; json; GeoTIFF

Optical Satellite Services for EMSA - OpSSERVE II

Service contract:
European Maritime Safety Agency EMSA

project partner: **EUSI** (contractor) and **DLR** (subcontractor)

project duration: **24 months** with
the option to extend by 12 months

project start: **October 2015**

project summary: **rapid access to satellite data and derived information** for use in maritime situational awareness

derived information at sea and coast :

- **Vessel detection**
- **Vessel activities**
- **Change detection**

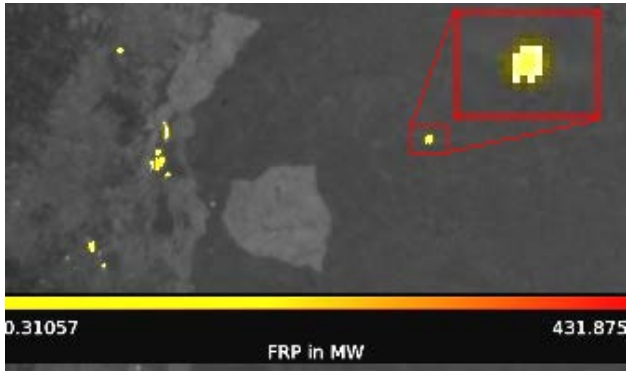
FireBIRD – Hot Spot Detection and Sea Surface Temperature

– Camera Parameter

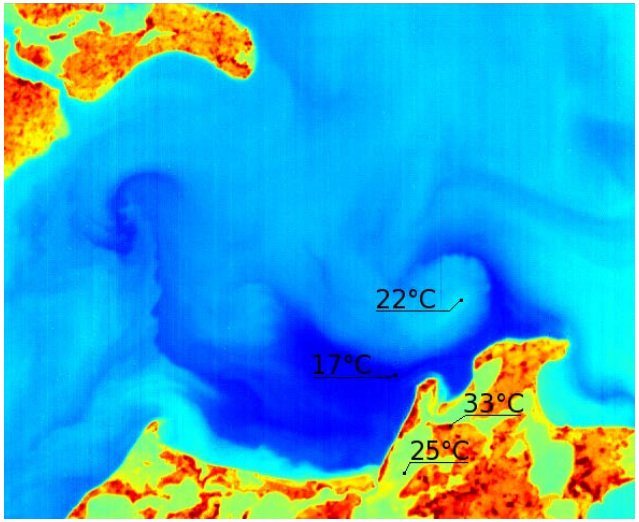
	3 line-VIS Camera (3 line FPA, 6 ° separated)	2 Infrared- Cameras (staggered lines)
Wave length	1 460 - 560 nm 2 565 - 725 nm 3 790 - 930 nm	MWIR: 3,4 - 4,2 µm LWIR: 8,5-9,3 µm
Pixel size	7 µm x 7 µm	30 µm x 30 µm
Number of Pixel	3 x 5164 (1250)	2 x 512 staggered
Quantization	14 bit	14 bit
Ground resolution	42,4 m 2)	356 m 2)
Ground sampling distance	42,4 m 2)	178 m 2)
Swath width	211 km 2)	178 km 2)

Main FireBird camera parameters [2] Altitude 510km

Fire Release Power Estimation



Sea Surface Temperature Estimation



FireBIRD – Sea Surface Temperatures (SST)

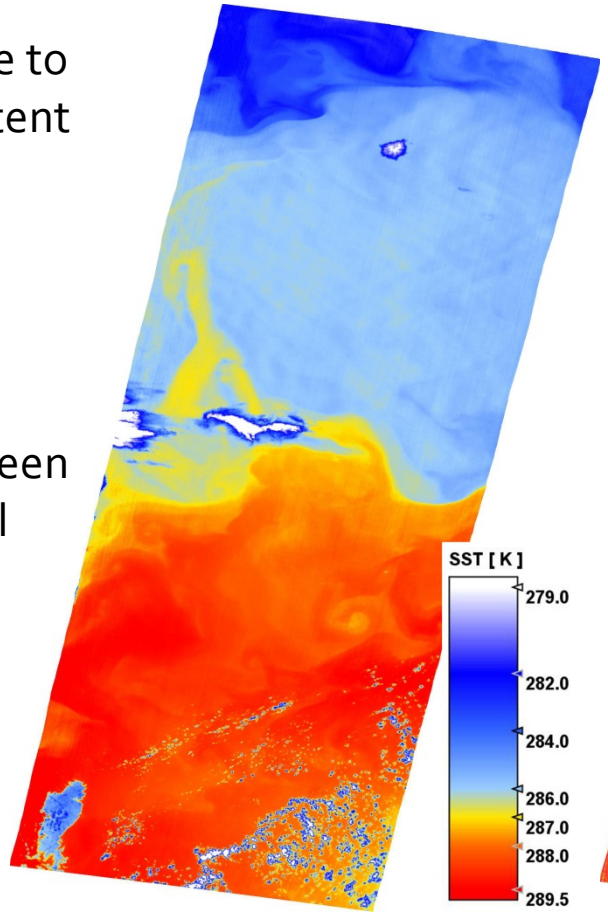
– Main source of error due to atmospheric water content (-6 … -9K)

– Estimation based on:
- Weather forecast
- Atmospheric model
- Intercomparison between MWIR and LWIR signal

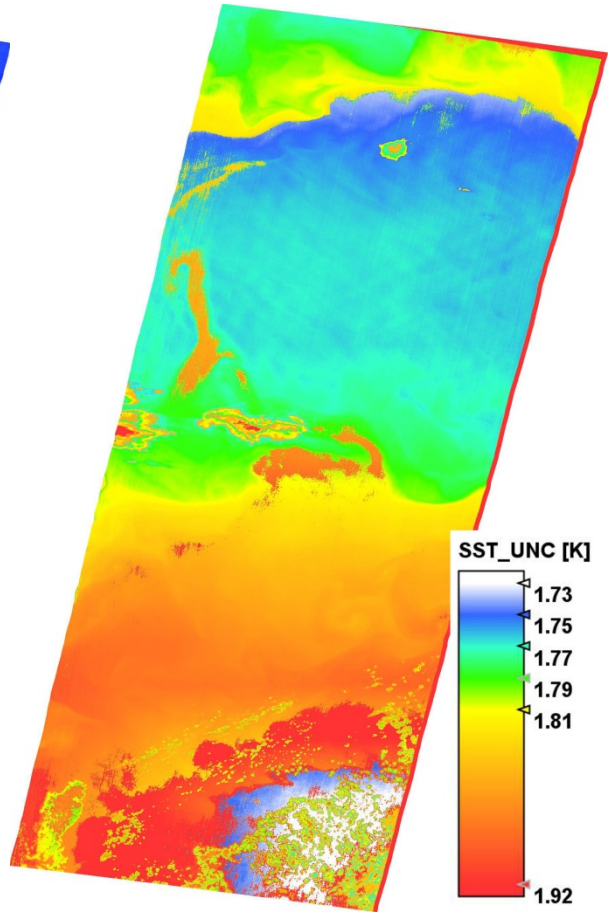
-> improved SST values

-> improved values of atmospheric water column

Ackn: N. Mettig; DLR-OS



Example Japan See
Estimated SST (atmospheric corrected)



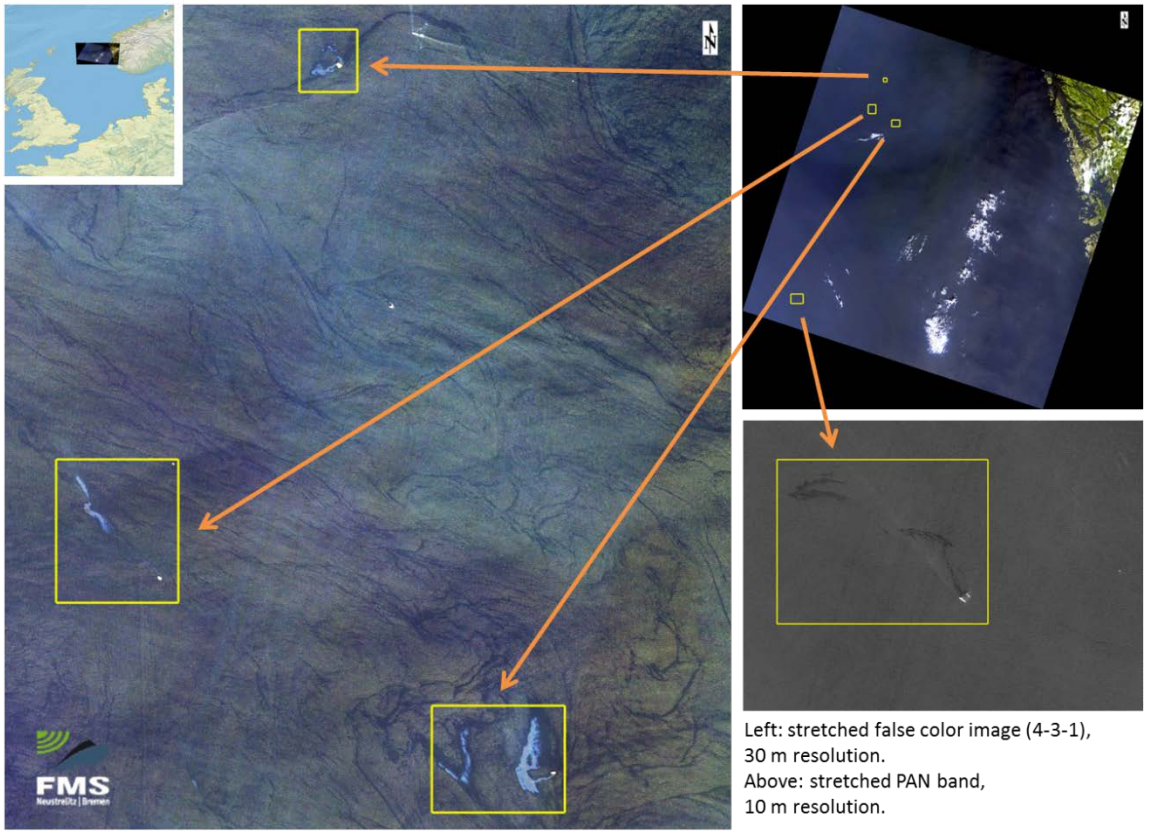
Estimation Error

Optical Sensor based Oil Spill Detection

Near real time oil spill detection application based on optical data

Core processor currently being developed by the Maritime Security_Lab Neustrelitz

planned value added products in near real time based on Landsat-8

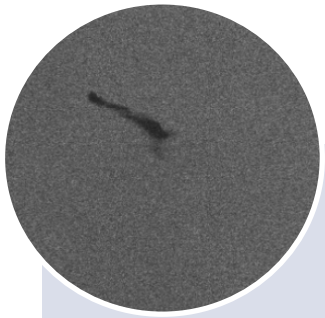


Left: stretched false color image (4-3-1), 30 m resolution.
Above: stretched PAN band, 10 m resolution.

Potential oil spills nearby platforms in the North Sea,

Landsat 8 OLI, 2014-07-11, 10:56 UTC

SAR based Oil Spill Detection



Near real time oil spill detection application based on SAR images

core function is the qualification algorithm developed by the Maritime Security Lab Bremen based on Neural Network

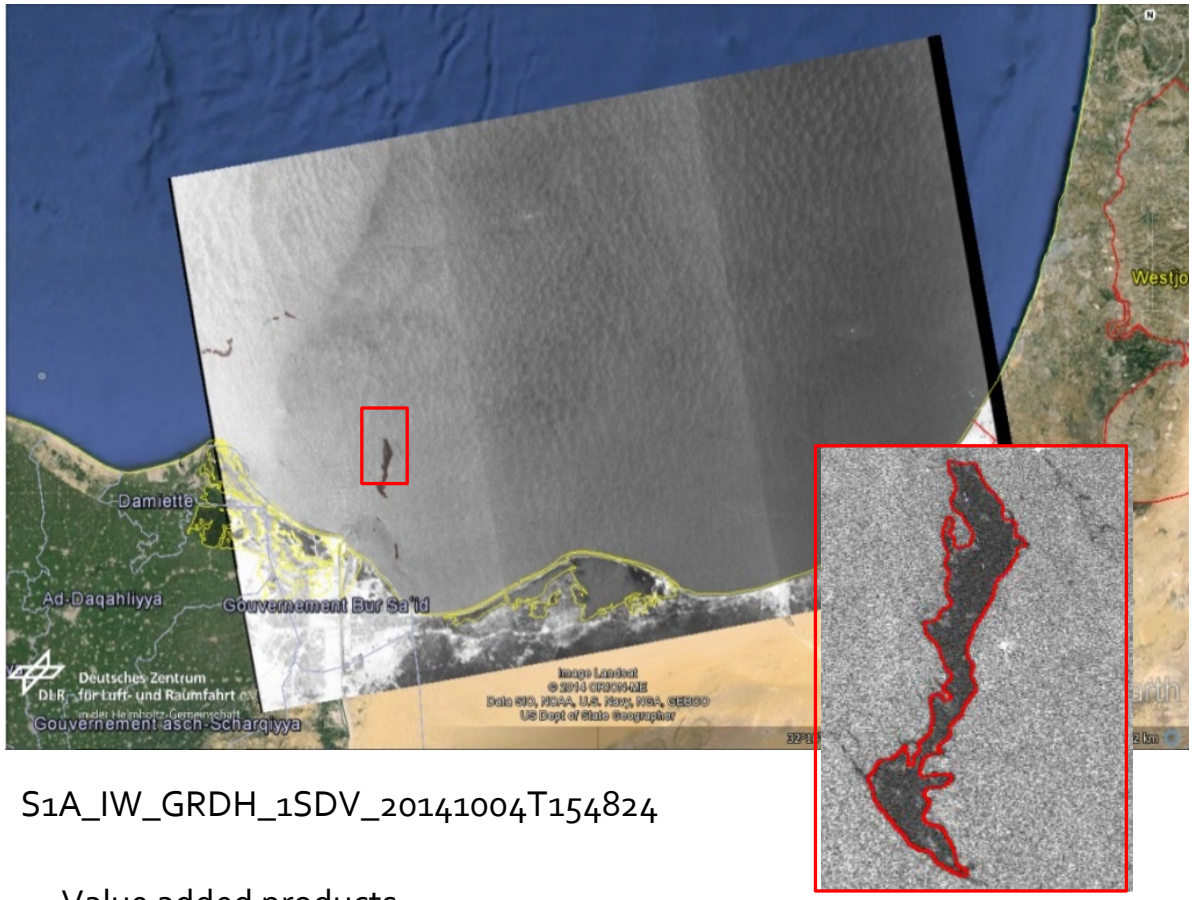
currently developed for:

TerraSAR-X, TanDEM-X

Radarsat-2, Sentinel-1A,

Sentinel-1B

Ackn: S. Singha; DLR- IMF



S1A_IW_GRDH_1SDV_20141004T154824

Value added products

- ASCII ; KMZ, GML; OSN (EMSA); ESRI shape; pdf;
- GeoTIFF (MRES_L1b; HRES_L1B)

Application for Wind field products

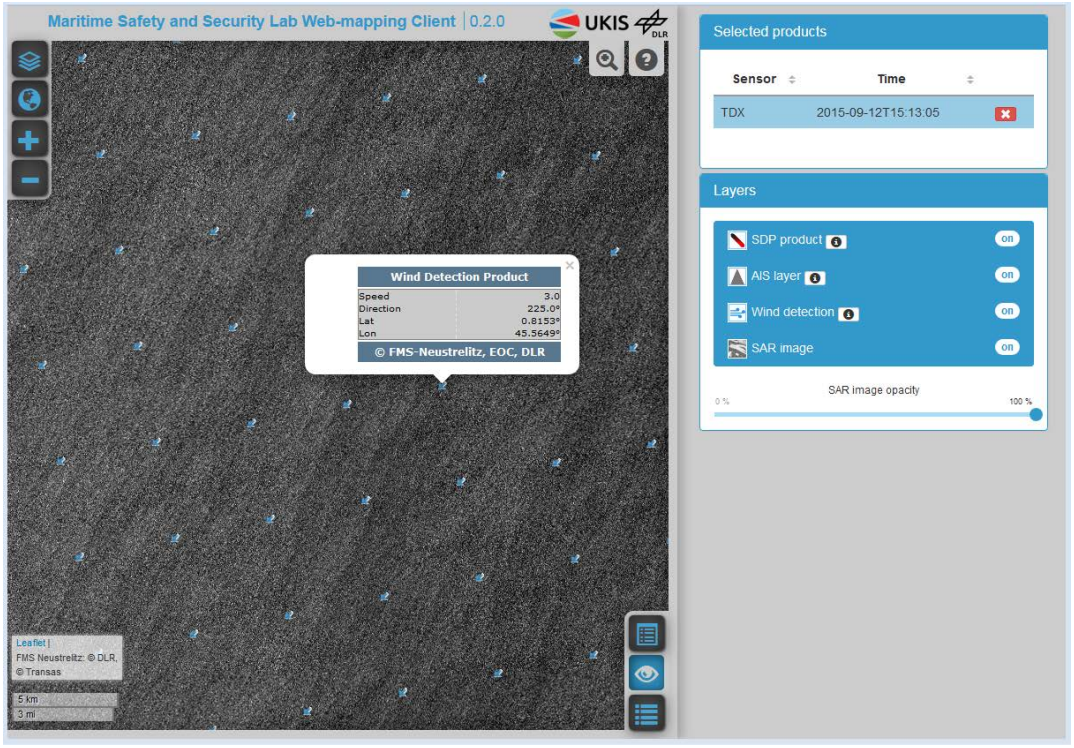


Image:
TDX1_SAR__MGD_RE___SC_S_SRA_20150912T151305_20150912T151310

The wind forecast and the Level 1 quicklook product in the background is overlaid by the DLR SAR WIND product (rectangle) derived from the Sentinel image.

- Core function is the XMOD-2 algorithm developed by the Maritime Security Lab Bremen to derive wind speed and direction, (Jacobsen et al., 2013)
- Forecast model is implemented to provide wind direction , the netCDF output is generated, containing the wind direction and intensity (WD10)
- Level 2 Produktformate
  - ASCII
  - netCDF
  - Google (KMZ)
  - png, wld, png.aux.xml
  - ESRI Shape Layer Files (shape)

Example for Wind field products based on Sentinel-1

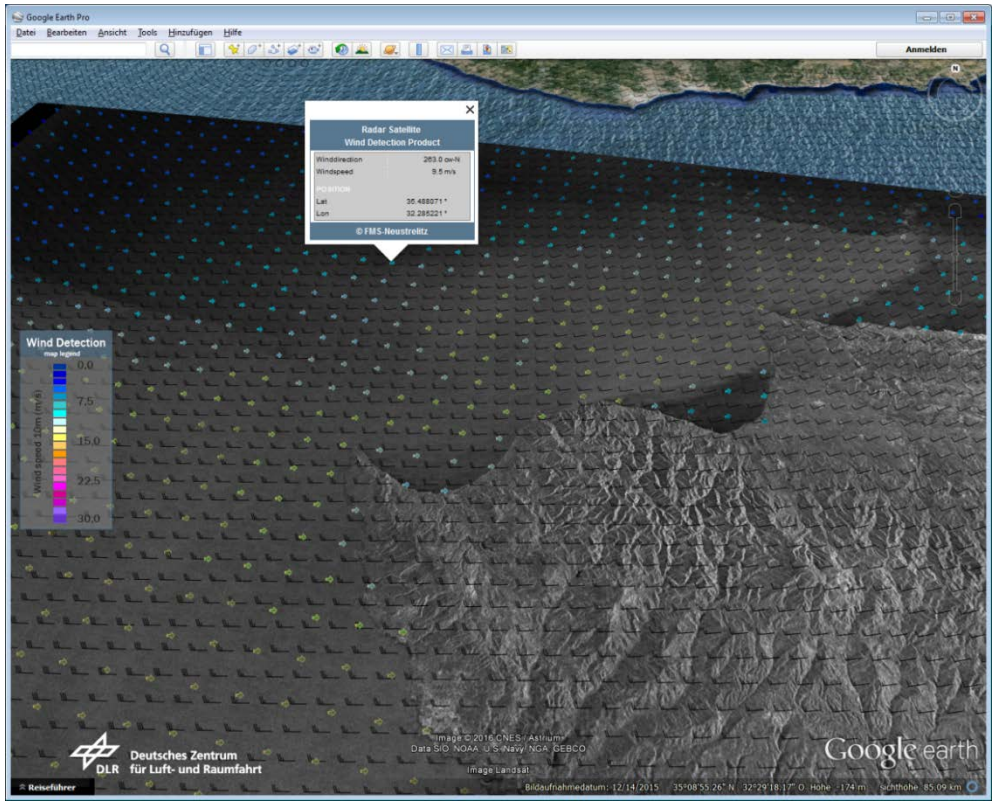
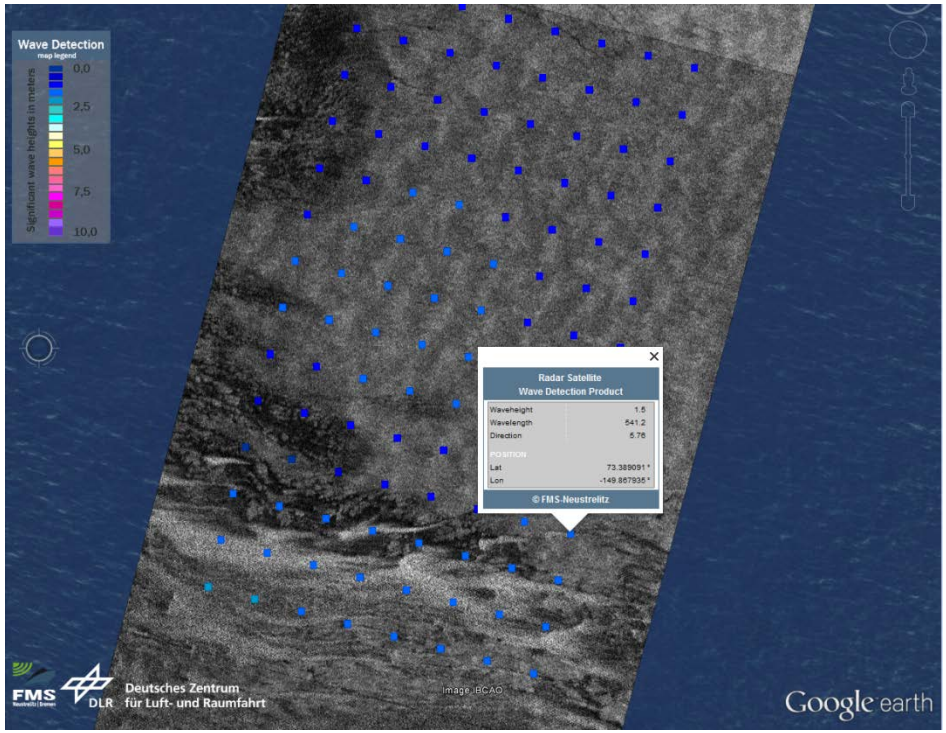


Image: S1A_IW_GRDH_1SDV_20160316T035101_20160316T035125

DLR SAR WIND product (rectangles) derived from the Sentinel image, wind forecast and Level 1 quicklook product as background.

- Core function is the CMOD-5 algorithm developed by the Maritime Security Lab Bremen to derive wind speed and direction, **validation ongoing,**
- Forecast model is implemented to provide wind direction , the netCDF output is generated, containing the wind direction and intensity (WD10)
- Level 2 Produktformate
  - ASCII
  - netCDF
  - Google (KMZ)
  - png, wld, png.aux.xml
  - ESRI Shape Layer Files (shape)

Application for Wave products based on Mission TerraSAR-X

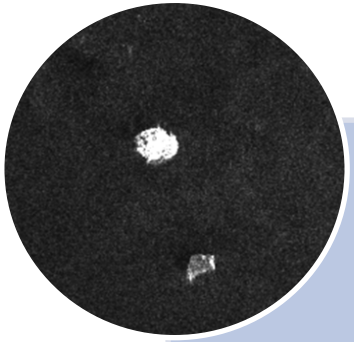


DLR SAR WAVE product (rectangles) derived from the TerraSAR-X StripMap image, L1 quicklook product as background.

- new XWAVE-2 algorithm developed by the Maritime Security Lab Bremen to derive wave height and wave length (Pleskachevsky et al., 2016)
- Level 2 Produktformate
  - ASCII
  - netCDF
  - Google (KMZ)
  - GIS, png, wld, png.aux.xml
  - ESRI Shape Layer Files (shape)

Pleskachevsky, A., Rosenthal, W., Lehner, S. (2016) Meteo-Marine Parameters for Highly Variable Environment in Coastal Regions from Satellite Radar Images. ISPRS Journal of Photogrammetry and Remote Sensing, Seiten 1-25. ELSEVIER. DOI: 10.1016/j.isprsjprs.2016.02.001. (in print)

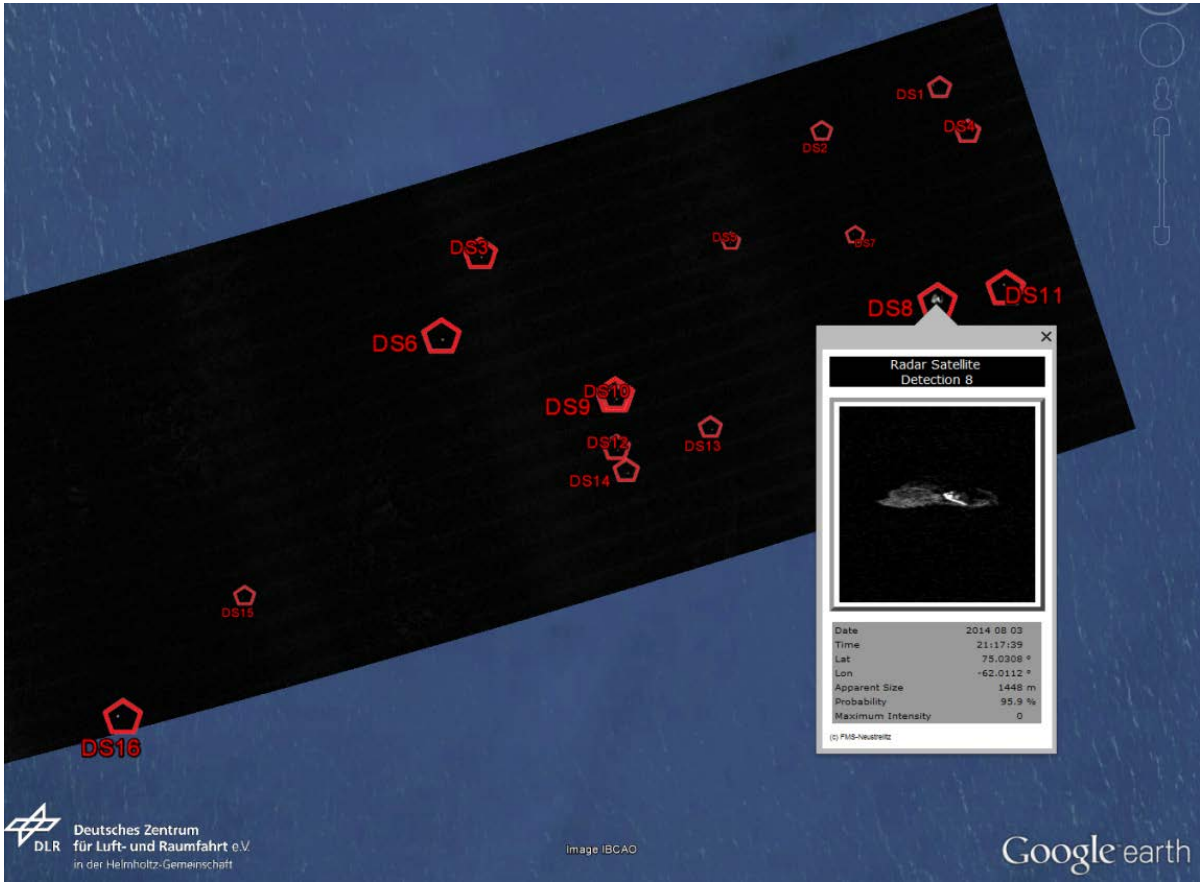
Iceberg- detection



Near real time iceberg detection application to Support Maritime Situation Awareness

- Ice Service Center
- Support Exploration Management and Resource planning
- Route management

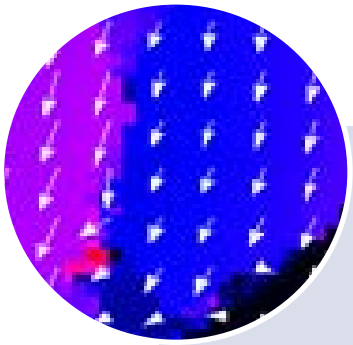
Ackn: A. Frost; DLR- IMF



TerraSAR-X ScanSAR Mode, Polarisation: HH, 150 km range,

Frost, Anja und Ressel, Rudolf und Lehner, Susanne (2015) Iceberg Detection over Northern Latitudes Using High Resolution TerraSAR-X Images. In: 36th Canadian Symposium of Remote Sensing - Abstracts. 36th Canadian Symposium of Remote Sensing, 8.-11. June 2015, ST. JOHN'S, NEWFOUNDLAND AND LABRADOR, CANADA.

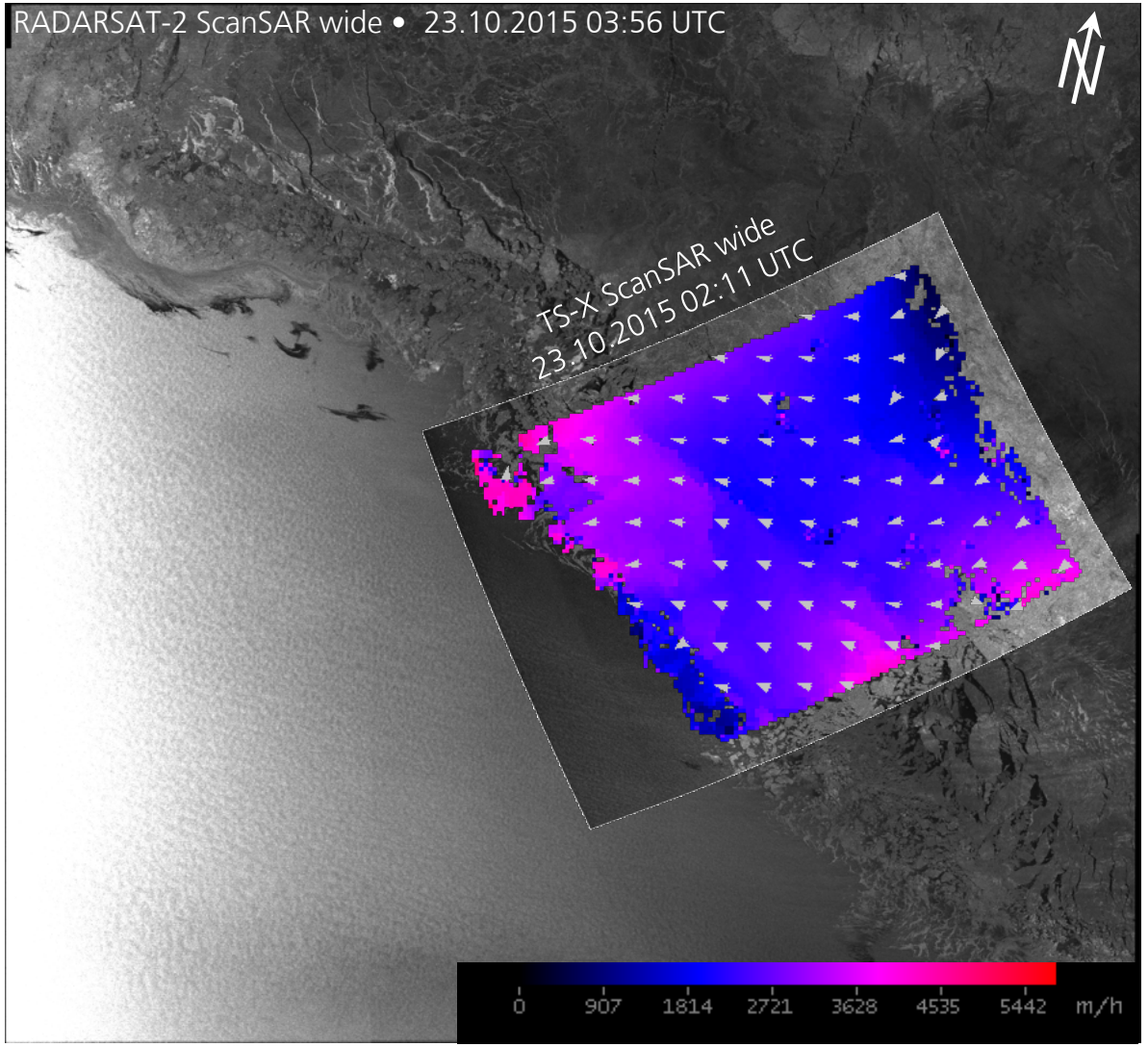
Ice Drift



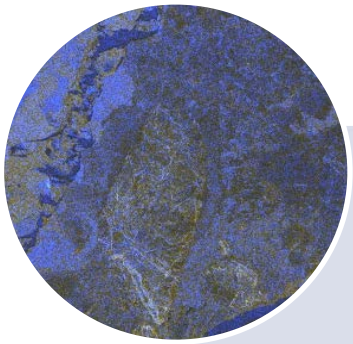
Near real time Ice drift application to Support Maritime Situation Awareness

Core processor currently being developed by the Maritime Security_Lab Bremen

planned value added products in near real time based on TerraSAR-X, Sentinel-1 and Radarsat-2



Ice Classification

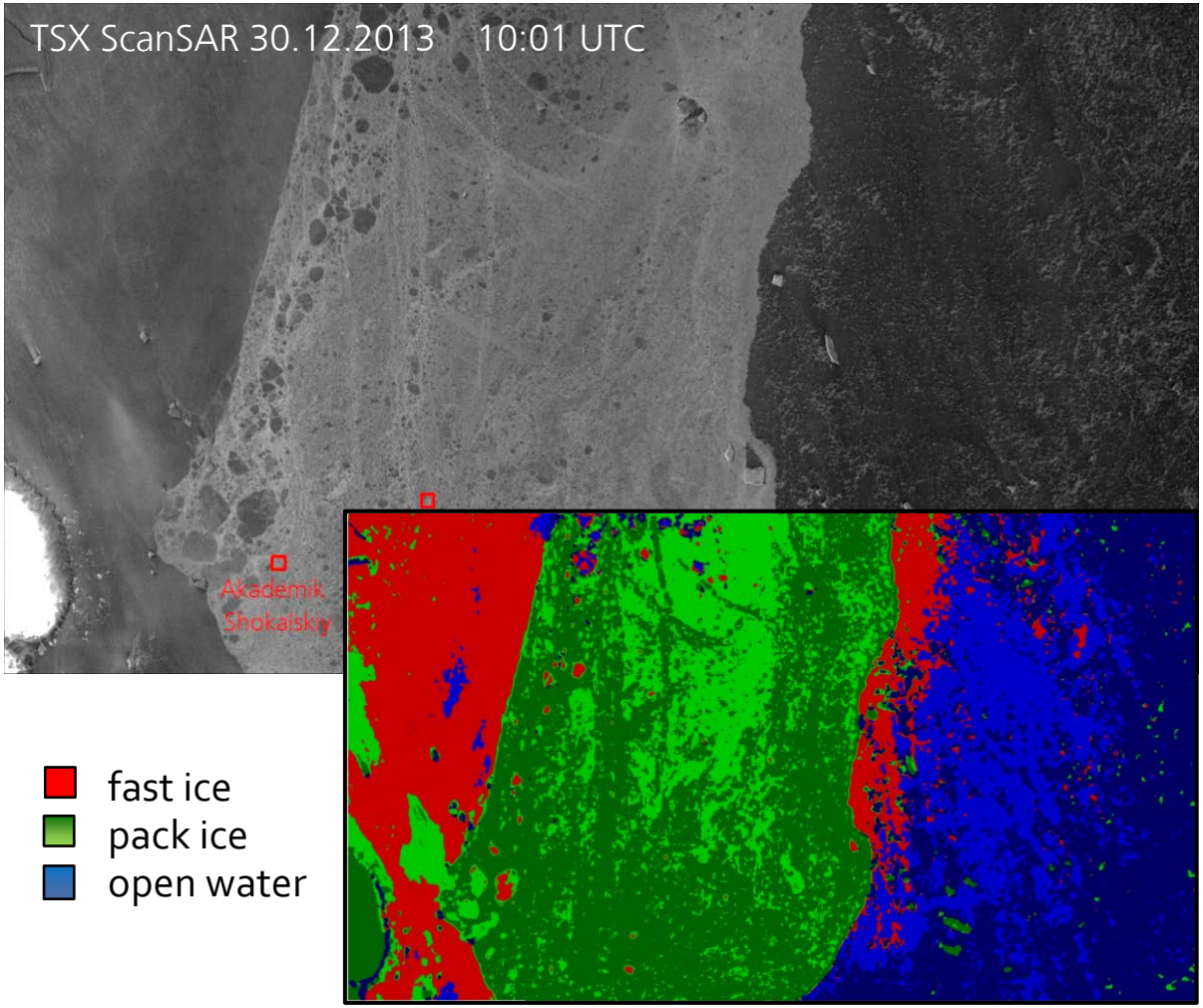


Near real time Ice drift application to Support Maritime Situation Awareness

Core processor currently being developed by the Maritime Security_Lab Bremen

Planned value added products based on TerraSAR-X (DualPol)

Ackn: S. Singha; DLR- IMF



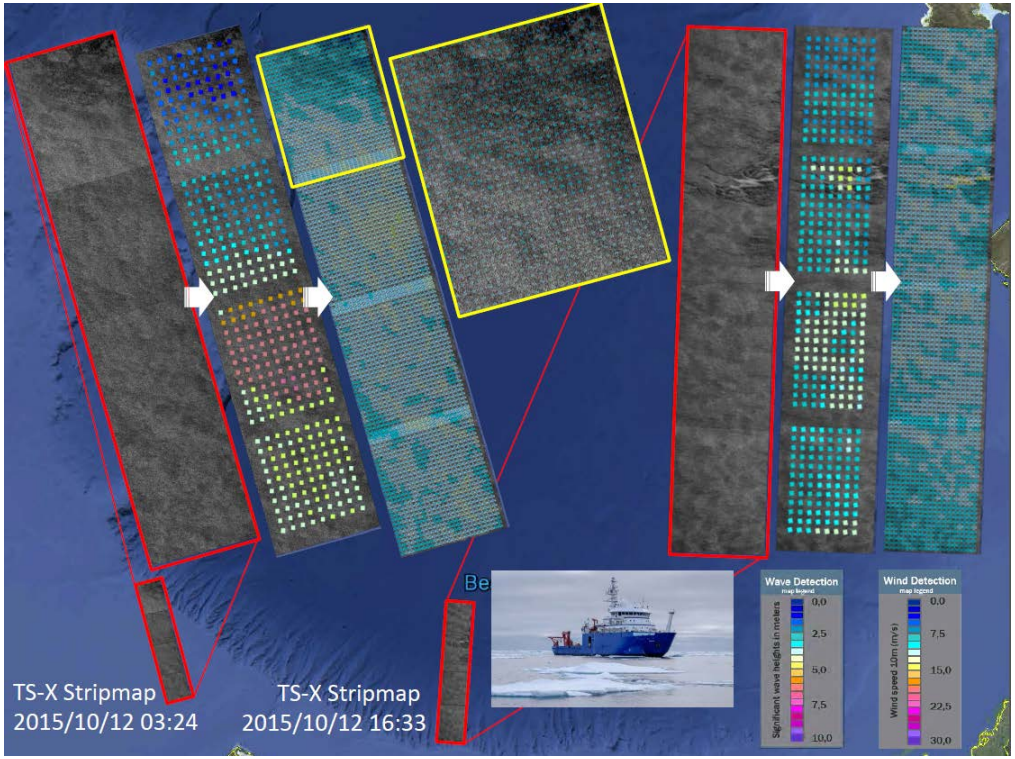
NRT Support for Office of Naval Research (ONR) Arctic Sea State Campaign 2015

Research Vessel Sikuliaq
Beaufort Sea

http://www.apl.washington.edu/project/project.php?id=arctic_sea_state

- TerraSAR-X support comprises
- additional SGS contacts used for D/L
- NRT L1b product delivery

- products deliveries for usage at ship Quicklook products in addition with wind and wave charts



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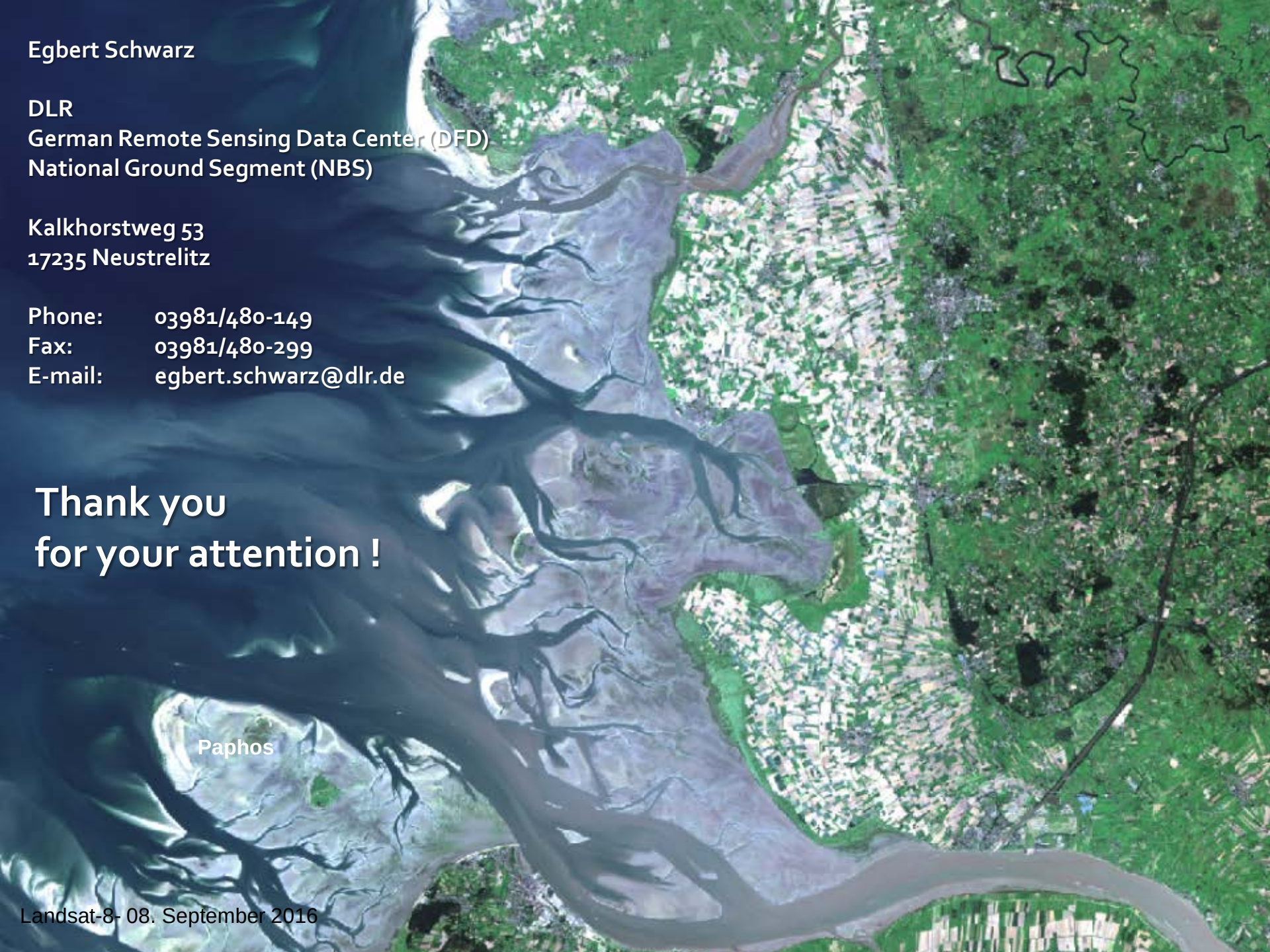
17235 Neustrelitz

Phone: 03981/480-149
Fax: 03981/480-299
E-mail: egbert.schwarz@dlr.de

Thank you for your attention !



Landsat-8- 08. September 2016